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SUPPLEMENTARY STUDIES FOR THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED SOHIO TRANSPORTATION SYSTEM

ERT Project No. P-5067

April 15, 1977

Environmental Research & Technology, Inc.
2625 Townsgate
Westlake Village, California 91361

AIR QUALITY IMPACT ASSESSMENT OF A ONE PERCENT GAS SUPPLY REDUCTION DUE TO PIPELINE CONVERSION

March 11, 1977

1.0 PROJECT BACKGROUND

It is presently anticipated that the abandonment of a mainline gas transmission line from the Permian Basin in New Mexico to California by El Paso Natural Gas Company would result in an approximate one percent gas supply reduction to El Paso's California customers[1]. The withdrawal from east to west gas delivery service of a thirty-inch (30") interstate pipeline is proposed by El Paso so that the pipeline and related rights of way and facilities may be available for use as part of SOHIO Transportation Company's proposed Alaskan crude oil transportation system. The curtailment of approximately one percent of the gas supply to El Paso's California customers will be caused by the increased fuel requirements of additional pipeline pumping stations, throughout the remainder of the pipeline transportation network. The immediate effect of the reduced gas supply would be increased curtailment of gas to the lower priority customers of the California distribution companies (see Table 1.1). Low priority (interruptable) gas customers would then burn fuel oil as a replacement fuel. It is anticipated that the use of this replacement fuel would result in increased emissions of SO_2 and particulates.

It was determined that the predominant volume of curtailed gas supply (approximately 60-70 percent of the total curtailment) could be anticipated by priority three (P-3) customers of the Southern California Gas Company (So Cal). (See Table 1.2.) The anticipated volume of natural gas subject to curtailment by So Cal is presented in Table 1.1. The net curtailment decreases with time as a consequence of projected reduced total El Paso deliveries to So Cal with or without the pipeline abandonment.

TABLE 1.1

El Paso Natural Gas, Gas Curtailment to So Cal Gas as a Consequence of Pipeline Abandonment (1)

	Gas Volume, mm of Month				
MONTH	77	78	79	80	81
1	0	297	251	222	194
2	0	240	207	190	169
3	0	280	215	188	170
4	396	305	216	178	140
5	383	331	230	170	-
6	419	347	298	219	-
7	271	368	317	248	-
8	309	361	314	247	-
9	265	343	305	242	-
10	375	376	227	365	-
11	356	272	230	209	-
12	293	239	214	192	-
	2,796	3,759	3,019	2,670	637
	(3,728)*				(2,019)*
Ave. Monthly Curtailment	311	313	252	223	168

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(1) Source: El Paso Natural Gas Company Exhibit MKO'T 7, filed 6/4/76, Docket No. CP75-362.

* Indicates value normalized to one full year.

TABLE 1.2

Natural Gas User Priority Classification

Priority 1	All residential usage regardless of size. Non-residential with peak day demands of 100 Mcf per day or less.
Priority 2-A*	Feedstock usage with no alternate fuel. Non-residential usage with peak day demands greater than 100 Mcf per day where the conversion to an alternate fuel is not feasible. Electric utility startup and igniter fuel.
Priority 2-B**	Service to customers on interruptible service schedules as of December 2, 1975 with liquefied petroleum gas or other gaseous fuel standby facilities and where the conversion to an alternate fuel is not feasible. Commission approved deviations from requirements for standby facilities.
Priority 3	All usage not included in another priority.
Priority 4	All boiler fuel usage with peak day demand in excess of 750 Mcf per day where capability of utilizing an alternate of fuel is present and cement plant kilns.
Priority 5	Utility steam electric generating plant usage and utility gas turbines.

Priority 3

Oil Refineries
Metal Producers
Food Processors
Paper Manufacturers
Government Facilities - City, County, State, Federal
Medium Size Hospitals
Commercial Buildings - Hotels, Clubs, Office Buildings
Universities
Soal Manufacturers
Metal Product Fabricators and Processors
Glass Manufacturers
Aero-Space Manufacturers
Chemical Manufacturers
Agricultural Product Processors
Plastic Manufacturers
Nurseries
Carpet Manufacturers
Entertainment Facilities
Film Processors
Laundries
Paving Manufacturers
Container Manufacturers
Rubber Processors

2.0 PROJECT SETTING

The Southern California Gas Company, El Paso's largest California customer, has provided information regarding the location of customers and the extent of the areas to be most affected by gas supply curtailment.[2] While a precise tabulation of affected customers was not available, a study area was identified, based upon gross customer counts throughout the South Coast Air Basin. Additionally, a primary study area covering portions of Southern Los Angeles County and extreme western Orange County, wherein the predominant portion (i.e. greater than 50%)of the curtailment would be concentrated, was identified (see Figure 2.1).

It should be noted that the only pollutants treated in this report are sulfur dioxide and particulates. The rationale for this limitation is that curtailment of natural gas will cause specific priority 3 users to switch to alternate fuels which have a higher sulfur content, but which do not cause a significant change in the emissions of other pollutants.

The 1975 areawide emissions inventory from the South Coast Air Quality Management District was also used to establish baseline conditions against which changes in emissions of SO_2 and particulate resulting from replacement fuel use could be compared. An emissions inventory for the Los Angeles County - Orange County primary study area is presented in Table 2.1.

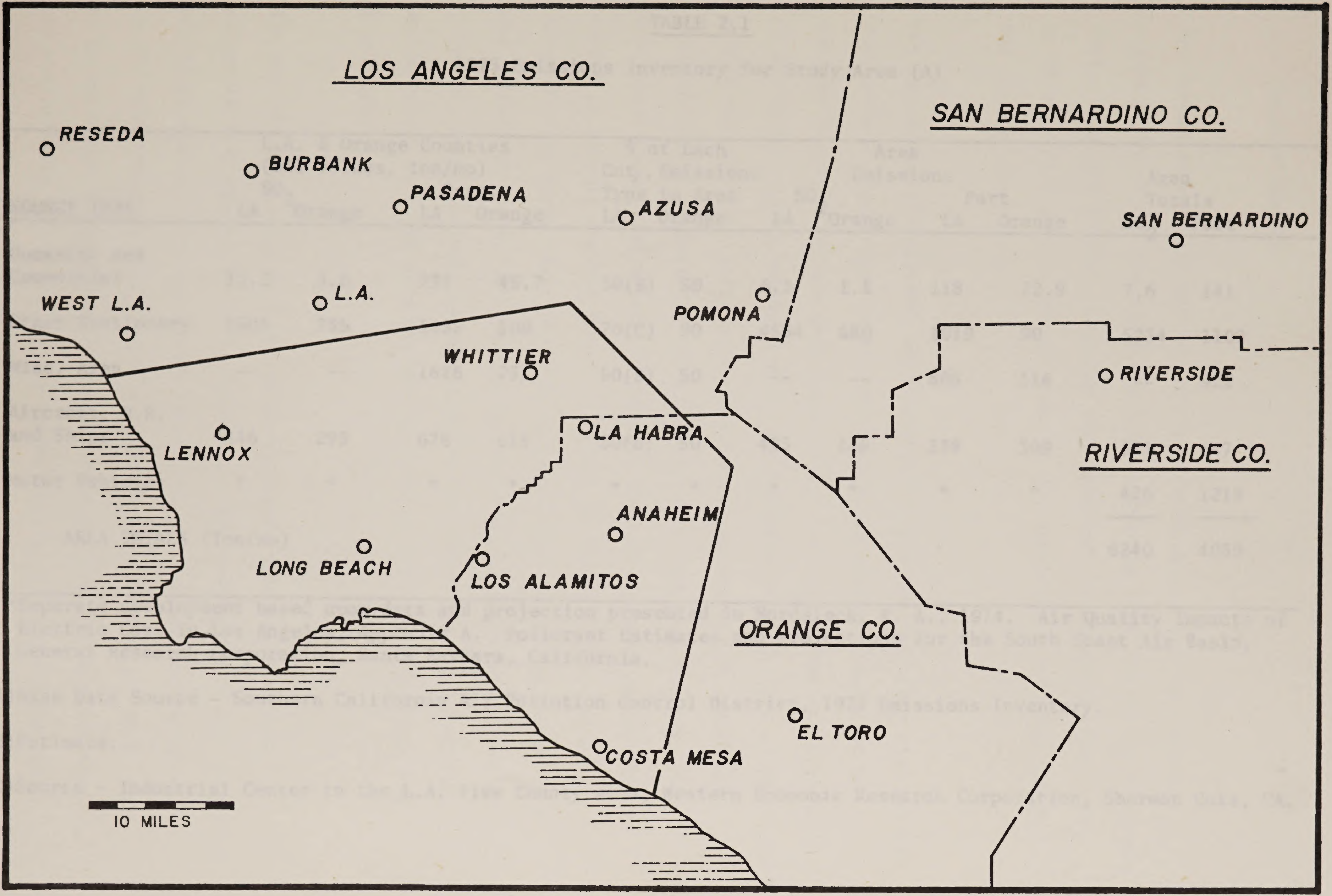
LOS ANGELES CO.
SAN BERNARDINO CO.
RESEDA
BURBANK
PASADENA
AZUSA
SAN BERNARDINO
WEST L.A.
L.A.
POMONA
WHITTIER
RIVERSIDE
LA HABRA
LENNOX
RIVERSIDE CO.
ANAHEIM
LONG BEACH
LOS ALAMITOS
ORANGE CO.
EL TORO
COSTA MESA
10 MILES

Figure 2.1 Primary Study Area

TABLE 2.1

1975 Emissions Inventory for Study Area (A)

SOURCE TYPE	L.A. & Orange Counties (all values, ton/mo)				% of Each Cnty. Emissions Type in Area		Area Emissions				Area Totals	
	SO_2		Part.				SO_2		Part			
	LA	Orange	LA	Orange	LA	Orange	LA	Orange	LA	Orange	SO_2	Part
Domestic and Commercial	12.2	3.0	237	45.7	50(B)	50	6.1	1.5	118	22.9	7.6	141
Other Stationary	6505	755	1455	100	70(C)	90	4554	680	1019	90	5234	1109
Misc. Area	--	--	1616	231	50(B)	50	--	--	808	116	--	922
Aircraft, R.R. and Ships	846	295	676	618	50(B)	50	423	148	338	309	571	647
Motor Vehicles	*	*	*	*	*	*	*	*	*	*	426	1218
AREA TOTALS (Ton/mo)											6240	4039

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*Separate development based upon data and projection presented in Nordsieck, R. A., 1974. Air Quality Impacts of Electric Cars in Los Angeles, Appendix A. Pollutant Estimates and Projections for the South Coast Air Basin, General Research Corporation, Santa Barbara, California.

(A)Base Data Source - Southern California Air Pollution Control District, 1975 Emissions Inventory.

(B)Estimate.

(C)Source - Industrial Center in the L.A. Five County Area, Western Economic Research Corporation, Sherman Oaks, CA.

3.0 PROJECT IMPACTS

Two scenarios were assumed for the purpose of evaluating the relative significance of the increased emissions resulting from the use of alternate fuels. The two project scenarios were examined, based upon either fifty or seventy-five percent of the total So Cal curtailment occuring within the primary study area.

The gas supply curtailments were translated into the necessary alternative fuel volumes (based upon equivalent heat value) and the increased SO_2 and particulate emissions (see Table 3.1). For a more complete discussion of the methodologies employed here, see Appendix A.) Two sets of emissions values were derived, based upon assumptions concerning the nature and availability of replacement fuels. With few exceptions, the affected air pollution control districts prohibit the use of fuels containing sulfur in amounts greater than 0.5 percent by weight.[3] This value was adopted as an upper limit for this analysis. One set of emissions data was calculated for 0.5 percent sulfur residual oil and a second set was prepared, using projections developed by the California Air Resources Board, which is based upon the availability of low sulfur fuel oil and distillate oil.

The calculated increases in emissions resulting from the use of an alternate fuel are presented in Table 3.2. Any comparison of the increased emissions due to curtailment with future SO_2 and particulate emissions in the South Coast Air Basin must account for the presumption that, due to an uncertain array of contingencies regarding new gas supplies and the availability of low sulfur replacement fuels, the use of the 1975

TABLE 3.1

SoCal Curtailments, Replacement Fuels, and Increased Emissions

	Curtailment		Increased Emissions (ton/month) (B)					
			Assume only 0.5% S Industrial Residual Oil			Assume C.A.R.B. Projection of 0.5 & 0.2% S Fuel and Distallage Oil		
YEAR	Ave. SoCal Curtailment (mmcf/mo)	Equiv. B.T.U. Replacement Oil (m gal/mo) (A)	Ave. %S	SO_2	Part (C)	Ave.% S(D)	SO_2	Part (C)
1977	311	2209	0.50	86.7	23.1	0.48	83.2	8.7
1978	313	2224	0.50	87.3	23.2	0.48	83.8	8.8
1979	252	1790	0.50	70.0	18.7	0.46	64.6	7.1
1980	223	1584	0.50	62.2	16.5	0.45	60.0	6.1
1981	168	1193	0.50	46.8	12.5	0.44	41.2	4.7

(A) Assumes 1,067 BTU/cf gas and 150,200 BTU/gal oil.

(B) Compilation of air pollution emission factors, EPA, March, 1975, AP-42.

(C) Corrected for natural gas emissions of 0.0 SO_2 and 15 lb particulate per 10^6 Cf. Assumes (0.157) x (% sulfur) lb SO_2/1000 gal oil. Assume 23 lb part/1000 gal for residual oil, 10 lb part/1000 gal for C.A.R.B. projected blend of fuel and distillate oil.

(D) "Pessimistic case" projection, from Effects of the Change Over From Natural Gas to Fuel Oil in the South Coast Air Basin", March 1975, State of California Air Resources Board.

TABLE 3.2

Emissions Impact

Local Percent Emissions Increase in L.A. County - Orange County Area of High Density P-3 Customer Locations

	1975 "Area" Emissions (ton/mo)		Portion of all SoCal P-3 Customers in Area							
			Assume 50%				Assume 75%			
			Residual Oil		Fuel & Dist. Oil		Residual Oil		Fuel & Dist. Oil	
YEAR	SO_2	Part	SO_2	Part	SO_2	Part	SO_2	Part	SO_2	Part
1977	6240	4039	0.69%	0.29	0.67	0.11	1.04	0.43	1.00	0.16
1978	6240	4039	0.70	0.29	0.67	0.11	1.05	0.43	1.01	0.16
1979	6240	4039	0.56	0.23	0.52	0.09	0.84	0.35	0.78	0.13
1980	6240	4039	0.50	0.20	0.48	0.08	0.75	0.31	0.72	0.11
1981	6240	4039	0.38	0.15	0.33	0.06	0.56	0.23	0.50	0.09

emission inventory as the baseline condition imposes a probable worst case scenario upon the percent increase analysis employed here. Referring to Table 3.2, in the seventy-five percent scenario, the maximum anticipated emissions increases are on the order of one percent or less. Assuming a linear relationship between increased emissions and ambient concentrations of those pollutants as described by:

$$\frac{X_p - B}{X_B - B} = \left(\frac{Q_p}{Q_B}\right) \qquad (1)$$

where: X_p = projected ambient concentration

X_B = base ambient concentration

Q_p = projected emissions

Q_B = base emissions

B = ambient concentration

and, assuming persistence of the existing source-receptor interaction, the impact upon ambient SO_2 and particulate concentrations are shown in Table 3.3.

TABLE 3.3

Projected Impact of Alternate Fuel Use in Primary Study Area

	Total Suspended Particulate Annual Geometric Mean, μg/m^3	
	Baseline Ambient Concentrations	Ambient Concentrations due to Curtailment
Lynwood	88	88.9
Lennox	93	93.9
Los Angeles	106	107.1

	Sulfur Dioxide Annual Arithmetic Mean, μg/m^3	
	Baseline Ambient Concentrations	Ambient Concentrations due to Curtailment
Long Beach	56.1	56.7
Whittier	66.8	67.4
Lennox	53.4	53.9

REFERENCES

1. El Paso Natural Gas Company Exhibit MKO'T, filed 6/4/76, FPC Docket No. CP 75-362.
2. Southern California Gas Company, Communication with Mr. Homer Ross.
3. State of California Air Resources Board (CARB), Effects of the Changeover From Natural Gas to Fuel Oil in the South Coast Air Basin, March 1975.
4. Nordsieck, R. A., Air Quality Impacts of Electric Cars in Los Angeles, Appendix A, Pollutant Emission Estiamtes and Projections for the South Coast Air Basin, August, 1974, (General Research Corporation, Santa Barbara).
5. Western Economic Research, Industrial Centers in the L.A. Five County Area, Western Economic Research Corporation, Sherman Oaks, CA.
6. Southern California Air Pollution Control District, 1975 Emissions Inventory.
7. EPA, Compilation of Air Pollution Emission Factors, March 1975, EPA, AP-42.
8. Federal Power Commission, Air Quality Impact as a Result of Abandonment 1976.

APPENDIX

Calculations Methodology

For Table 3.1:

A. Volume of replacement fuel (m gal/mo) =

$$\frac{\text{(gas curtailment, cf/mo) (heat valve, BTU/cf)}}{\text{(Oil, BTU/gal) x (1000 gal/m gal)}}$$

B. Particulate emissions increase:

(1) for residual oil, particulate (ton/mn:/n gal) =

$$\frac{\text{(replacement fule volume, m gal) x (23 lb particulate/m gal)}}{\text{2000 lb/ton}}$$

(2) for fuel and distillate oil, particulate (ton/mo/n gal) =

$$\frac{\text{(replacement fuel volume, n gal) x (10 lb particulate (n gal)}}{\text{2000 lb/ton}}$$

(3) correction for natural gas emissions, to be subtracted from (1) and (2).

natural gas particulate emissions (ton/mo) =

$$\frac{\text{(nn cf/mo) x (15 lb particulate (nn cf)}}{\text{2000 lb/ton}}$$

C. SO_2 emission increase, assuming no SO_2 emissions from natural gas.

(1) for 0.5% sulfur residual oil, SO_2 (ton/mo/n gal) =

$$\frac{\text{(oil volume, n gal/mo) x (157 x \% sulfur content) x (lb, } SO_2\text{)}}{\text{2000 lb/ton}}$$

(2) for fuel and distillate oil, SO_2 (ton/mo/n gal) =

$$\frac{\text{(oil volume, n gal/mo) x (157 x \% sulfur content) x (lb, } SO_2\text{)}}{\text{2000 lb/ton}}$$

MIDLAND OXIDANT STUDY

April 15, 1977

INTRODUCTION

These studies have been prepared for the Bureau of Land Management to supplement the Final Environmental statement prepared for the crude oil transportation system from Valdez, Alaska to Midland, Texas, proposed by SOHIO Transportation Company. The reports have been prepared under contract #YA152-CT6-181.

The proposed system will transport up to 700,000 barrels of oil per day from Valdez, Alaska to Long Beach, California using a fleet of tankers. The oil will then be transshipped via the proposed pipeline to Midland, Texas. It is anticipated that the pipeline will carry 500,000 barrels per day and that 200,000 barrels per day will be utilized by refineries in Southern California.

These reports have been prepared at the request of the BLM to respond to comments received on the Draft ES concerning two areas of potential air quality impact. An analysis of the oxidant impacts expected in the vicinity of Midland, Texas has been performed using the same general photochemical modeling methodology employed for the Los Angeles Basin; and the potential impacts of offshore tankship operations on oxidant and SO_2 levels in the Los Angeles Basin and the Ventura-Santa Barbara areas have been evaluated. The following sections include the additional material and revisions to existing sections in the Final ES

necessary to incorporate the major results of these analyses. Where possible appropriate section numbers from the Final ES have been employed.

3.1.6.3.2 Operation

Oxidant

During normal operations, the only significant project-related source of oxidant precursor emissions would be the four 500,000-barrel oil storage tanks at the Midland terminal. The reactive hydrocarbon vapor losses from these tanks have been calculated by the API method (API, 1962) and are presented in Table 3.1.6.3.2-1.

Table 3.1.6.3.2-1

Calculated Reactive Hydrocarbon Emissions from Oil Storage Tanks at Midland[a]

THROUGHPUT (bbl/d)	Standing Evaporation loss (lb/d)	Withdrawal Losses (lb/d)	Total Emissions (lb/d)
Project (500,000 bbl/d)	1,410	160	1,570

[a] Assumptions: API calculation method (API, 1962) for 4-500,000 tanks (in Appendix A3.1.6.1).

The details of the emission calculations are presented in Appendix A3.1.6.1.

Following the same general methodology employed for the Los Angeles Basin analysis (see section 3.1.6.1 and Appendix A3.1.6), existing sources of pollutant emissions were located geographically and a trajectory analysis was performed to identify possible paths of air pollutant transport from the proposed terminal site to the only oxidant monitoring station in the area, located in Odessa about 20 miles southwest of Midland. Hourly average ozone measurements at the Odessa station for the months of January through September 1976 were obtained from the Texas Air Control Board (TACB). Among these measurements, exceedances of the 8 pphm Federal Standard were recorded in March, May, June, August, and September with the highest reading (15.3 pphm) occurring in an isolated one-day episode on September 10. By far the highest number of violations (104) occurred during August including one seven-day episode. An analysis of the air trajectories arriving at Odessa on 10 high oxidant days in August showed a predominance of flow from the southeast quadrant, an area dotted with oil and petrochemical production and refining facilities. However, on August 29, the first day of a three-day oxidant episode, flow from the northeast prevailed and a trajectory was identified which starts north of Midland in the early morning, passes over the proposed SOHIO terminal site at 0900 (CST), and travels south and west reaching Odessa at about 1430. Hence, August 20, 1976 was selected as a base day for calibration of the model.

A review of Rawinsonde data collected at Midland and Big Spring, Texas

in June and July of 1976 under the HIPLEX program indicates that temperature inversions are very infrequent in the Midland vicinity and are very high in the few instances reported. Based on the HIPLEX temperature profiles, vertical mixing was modeled as progressing from slightly stable at 0800 to unstable at 1500 CST with no lid.

Pollutant emissions information for the Midland-Odessa area was obtained from the TACB including inventories of stationary point sources in Midland and Ector Counties, VMT and population estimates for both counties and for the cities of Midland and Odessa, and population projections for both counties. Future VMT levels in Midland and Odessa were estimated by population scaling, assuming that the ratio of each city's population to its county's population remained unchanged in the future. Table 3.1.6.3.2-2 shows the projected county populations and resulting VMT and emission growth factors employed to project the base year data obtained from the TACB.

It was assumed that 90% of all distributed source HC and NO_x emissions (i.e. those not included in the 1976 point source inventories obtained from the TACB) are contributed by vehicle traffic. The VMT data supplied by the TACB for 1975 reports 514.8×10^6 miles/year in Midland County and 576.6×10^6 miles/year in Ector County. In 1970, 91% of Midland County residents lived in the City of Midland, and in Ector County, 85% lived in Odessa. These percentages were used to adjust the reported and projected

Table 3.1.6.3.2-2

Population Projections and Emission Growth Factors for Midland and Ector Counties[a]

	Midland County		Ector County	
YEAR	Population	Emission Growth Factor	Population	Emission Growth Factor
1970	64,433	1.0	91,805	1.0
1975	65,945	1.0078	94,377	1.0280
1976	66,047	1.0094	94,891	1.0336
1980	66,457	1.0156	96,949	1.0560
2000	73,510	1.1234	114,809	1.2506

county VMT figures to the two cities. Vehicular emissions were then calculated using AP-42, Supplement 5 (EPA, 1975)(2), assuming a 5% heavy-duty vehicle mix, an average speed of 40 mph, and a hydrocarbon reactive fraction of 0.887 (CARB, 1976). Hydrocarbon reactive fractions for the point sources along the trajectory path are also based on California Air Resources Board estimates for each source type (CARB, 1976). For purposes of distributing the city emissions, the population areas of the two cities were estimated at 13.4 sq. mi. for Midland and 15.7 sq. mi. for Odessa.

Table 3.1.6.3.2-3 shows the schedule of fluxes of reactive HC and nitric oxide (NO) entering the air parcel as it follows the August 29 trajectory described earlier.

Table 3.1.6.3.2-3

Pollutant Emission Schedules for August 29 Air Trajectory

(Equivalent tons/year on a 4 x 4 mile grid)

Central Standard Time	1976 RHC	1976 NO	1980 RHC	1980 NO	2000 RHC	2000 NO
0823	3616.4	290.12	2405.6	2081.7	733.4	1129.7
0900	0	0	(286.5)*	0	(286.5)*	0
0939	0	0	0	0	0	0
1313	36.1	361.3	38.1	381.5	45.2	451.8
1318	542.7	648.9	573.1	685.2	678.7	811.5
1406	9956.3	7191.5	10513.9	7594.2	12451.3	8993.7
1416	14126.9	10204.9	13319.1	9673.4	13333.4	9970.5
1420	13620.3	9917.3	12784.2	9369.7	12699.9	9610.8
1500	0	0	0	0	0	0

*Emissions from proposed SOHIO terminal.

From 0823 to 0900, the air parcel is traversing the populated area of the City of Midland. At 0900 it reaches the site of the proposed pipeline terminal and storage facility on the southeast edge of the city. Then for about 3 1/2 hours the path of the air parcel is south and west across sparsely populated flat plains containing no identifiable sources of emissions. Starting at 1313, the air parcel begins to encounter various

industrial facilities located to the east and southeast of Odessa, in particular, a complex of petrochemical plants and an oil refinery, before reaching the populated portion of Odessa at about 1420. The center of the trajectory passes within about a mile of the Odessa monitoring station at 1434. The emission schedules shown in Table 3.1.6.3.2-3 give rise to an oxidant buildup along the trajectory which reaches a maximum at about 1400 as the air parcel nears the county line. Then the effects of nitric oxide scavenging of the ozone produce a steady decline in ground level ozone until the trajectory has cleared the city of Odessa.

On August 29, 1976, the hourly average ozone concentration at 1434 CST (by interpolation) at the Odessa monitoring station was about 9.1 pphm. The initial pollutant concentrations (at 0800) used in ARTSIM were adjusted during the calibration process to permit reproduction of this 9.1 pphm ozone level at Odessa. The final, calibrated ground level concentrations of NO, NO_2 and RHC were 1.0, 1.9 and 4.64 pphm respectively.

Table 3.1.6.3.2-4 compares the results of the baseline (no project) and project impact simulations runs. The ozone increments in 1980 and 2000 are both seen to be 0.18 pphm which must be considered negligible in comparison to the uncertainties inherent in both the input data and current knowledge of photochemical modeling.

industrial facilities located to the east and southeast of Odessa, in particular, a complex of petrochemical plants and an oil refinery, before reaching the populated portion of Odessa at about 1420. The center of the trajectory passes within about a mile of the Odessa monitoring station at 1434. The emission schedules shown in Table 5.1.6.3.2-3 give rise to an oxidant buildup along the trajectory which reaches a maximum at about 1400 as the air parcel nears the county line. Then the effects of nitric oxide scavenging of the ozone produce a steady decline in ground level ozone until the trajectory has cleared the city of Odessa.

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Table 5.1.6.3.2-4 compares the results of the baseline (no project) and project impact simulations runs. The ozone increments in 1980 and 2000 are both seen to be 0.15 pphm which must be considered negligible in comparison to the uncertainties inherent in both the input data and current knowledge of photochemical modeling.

Table 3.1.6.3.2-4

Calculated Ozone Concentrations at the Odessa Monitoring Station

(pphm)

SCENARIO	1976	1980	2000
Baseline	9.1	9.79	9.81
With SOHIO Terminal	-	9.95	9.99

Maintenance

Emissions from vehicles and other equipment for maintenance of terminal facilities would be very small; and, therefore, no impact is expected. The pipeline would be serviced from the El Paso, Texas maintenance base.

ONSHORE AIR QUALITY IMPACTS OF
OFFSHORE TANKSHIP OPERATIONS

April 15, 1977

3.1.6.4 Onshore Air Quality Impacts of Offshore Tankship Operations

3.1.6.4.1 Oxidant

In order to estimate ozone buildup resulting from emissions generated off the Southern California coast during tanker ballasting and purging operations, a Gaussian plume formulation was developed and combined with ARTSIM runs representing trajectories in Los Angeles and Ventura Counties. The Los Angeles simulations were modeled using the September 29, 1969 conditions used previously, while the Ventura County case utilized a trajectory which originated in the Santa Barbara Channel, came onshore near Port Hueneme, and arrived at the Simi Valley at 1400 PST.

Emission factors determined for the simulations considered a 165,000 DWT tanker located 8 km. offshore. The tanker's deck was assumed to be 12 ft. above the waterline, with 2 loading manifolds, each 16 inches in diameter and 3 ft. above deck level, the sources of the fugitive emissions; the combined cross-sectional area of the manifolds was 2.79 square feet. Gas was assumed expelled by an inert gas blower with 6,250 CFM flow rate, resulting in 11.4 m/sec exit velocity. Since gas was assumed to be at ambient temperature, plume rise would be due to the momentum component only, and was assumed to be 10 meters.

Emission rates, totals of both fugitive vapor and stack (combustion)

components, for the two operations are shown in Table 3.1.6.4.1-1. RHC totals were obtained by assuming emissions of 1.2 lb/10^3 gal carried; NO_x figures were obtained from Section 3.1.6.1 of the air quality supplement, and assumed to be entirely nitric oxide (NO).

Table 3.1.6.4.1-1

Emission Rates for Ballasting and Purging Operations

SCENARIO	Emission rate (lb/hr) Reactive Hydrocarbons (RHC)	Oxides of Nitrogen (NO_x)
Ballasting	2054.7	64.4
Purging	2973.1	91.7

Plumes from the tankers were assumed to be advected directly to shore, during slightly stable conditions (Pasquill-Gifford "E" class), by a 3 m/sec wind. Concentrations at ground level within the plume at the shoreline (8 km downwind) were determined using the well-known Gaussian equation

$$\chi = \frac{Q}{\pi u \sigma_y \sigma_z} \exp\left(-y^2/2\sigma_y^2\right) \exp\left(-h^2/2\sigma_z^2\right)$$

where χ = concentration (g/m^3)

u = mean wind speed = 3 m/sec true velocity and 8.3 m/sec apparent velocity from ship

Q = source strength of emissions (g/sec)

σ_y = horizontal (crosswind) standard deviation term (m.)

components, for the two operations are shown in Table 3.1.6.4.1-1. RHC totals were obtained by assuming emissions of 1.7 lb/10^3 gal carried; NO$_x$ figures were obtained from Section 3.1.6.1 of the air quality supplement, and assumed to be entirely nitric oxide (NO).

Table 3.1.6.4.1-1

Emission Rates for Ballasting and Purging Operations

SCENARIO	Emission rate (lb/hr) Reactive Hydrocarbons (RHC)	Oxides of Nitrogen (NO$_x$)
Ballasting	2054.7	64.4
Purging	2973.1	91.7

Plumes from the tankers were assumed to be advected directly to shore, during slightly stable conditions (Pasquill-Gifford "E" class), by a 3 m/sec wind. Concentrations at ground level within the plume at the shoreline (8 km downwind) were determined using the well-known Gaussian equation

$$\chi = \frac{Q}{\pi u \sigma_y \sigma_z} \exp\left(-y^2/2\sigma_y^2\right) \exp\left(-h^2/2\sigma_z^2\right)$$

where χ = concentration (g/m^3)

u = mean wind speed = 3 m/sec true velocity and 8.3 m/sec apparent velocity from ship

Q = source strength of emissions (g/sec)

σ_y = horizontal (crosswind) standard deviation term (m.)

σ_z = vertical standard deviation term (m.)

y = crosswind distance from plume centerline (m.)

h = effective stack height = 10 m.

Concentrations at the shoreline were averaged over a 1 km. sector extending 500 m. on either side of the plume centerline. Since σ_y at the shoreline was 417.4 m., this sector represents a total width of 2.4 σ_y.

It is readily apparent from the Gaussian concentration equation shown above that pollutant concentrations vary inversely with wind speed, and are thus very strongly affected by the particular value chosen for that parameter. Emissions from a moving source, such as the tanker, can be treated in two ways: emissions can be considered as an instantaneous "puff" liberated from a fixed point and advected shoreward by the true wind (in this case, 3 m/sec); or they can be considered as being short-term continuous emissions from a moving source, and subjected to initial dilution from the apparent wind (the resultant vector sum of the true wind and the ship's movement -- in this case 8.3 m/sec). The actual situation is probably somewhere between the two values: it is expected that enhanced initial dilution would occur near the ship, but it is doubtful that such dilution would continue over the entire 8 km. distance to shore. For that reason, 3 and 8.3 m/sec were considered as lower and upper bounds, respectively, in the calculations; concentration estimates are shown in Table 3.1.6.4.1-2.

Table 3.1.6.4.1-2

Estimated RHC and NO Concentrations

8 km Downwind of Tanker

		RHC Concentration		NO Concentration	
SCENARIO	Wind Speed (m/sec)	ug/m^3	ppm	ug/m^3	ppm
Ballasting	3.0	285	.236	9	.008
	8.3	103	.085	3	.003
Purging	3.0	413	.341	13	.011
	8.3	149	.123	5	.004

In addition, above-surface concentration values were computed. Assuming complete reflection, again, surface concentrations above were modified by the values in Table 3.1.6.4.1-3 for use aloft:

Table 3.1.6.4.1-3

Multiples of Computed Surface Concentration Increment

Used at Above-Surface Levels

Height	Multiply surface value by
100 m.	.865
200 m.	.533
300 m.	.237
400 m.	.076

The above values were employed as precursor increments added to initial concentrations of RHC and NO in baseline ARTSIM runs. Resultant ozone levels predicted by ARTSIM represented, therefore, the expected onshore impacts of offshore tanker emissions.

Los Angeles Basin

ARTSIM impact runs for the Los Angeles Basin were conducted by using trajectory H-8 (passing over the Hynes site at 0800 PDT) for 1980. To the baseline run, as described in Section 3.0.1.2, were added the additional RHC and NO increments shown above. Four runs were made, to model effects of both ballasting and purging operations, assuming initial wind speeds of 3.0 and 8.3 m/sec. Ozone concentrations at 1500 PDT for each of the four cases are compared with the baseline values in Table 3.1.6.4.1-4.

Table 3.1.6.4.1-4

Impacts of Offshore Tanker Ballasting and Purging Operations Upon Los Angeles Basin Ozone Concentrations. Trajectory H-8, 1980

Time 1500 PDT

SCENARIO	Initial Wind Speed (m/sec)	Ozone Concentration (pphm) Baseline Run	Ozone Concentration (pphm) Impact Run
Ballasting	3.0	20.6	26.1
	8.3	20.6	22.6
Purging	3.0	20.6	28.2
	8.3	20.6	23.9

Santa Barbara - Ventura Counties

The north-south shipping lanes along the California coast pass within the Santa Barbara Channel, north and east of the Santa Barbara Channel Islands, and, at the eastern end of the Channel, lie within a few miles of the Ventura County coastline. Ballasting/purging operations, if they were to occur in that vicinity, might have significant impacts upon local ozone concentrations. In order to model such impacts, a trajectory was selected from Taylor (1977), which originated over the Channel at 0800 PDT on July 10, 1975, traversed the shipping lanes, arrived onshore at 1000 PDT, and reached the Simi Valley, an inland basin in eastern Ventura County, at 1400. Initial conditions and surface emissions for 1983 were assumed; baseline ozone concentration upon arrival of the air parcel at Simi was 17.0 pphm.

Concentration increments added to baseline RHC and NO profiles were the same as those used in the Los Angeles Basin simulations described above. Results of the four impacts runs are shown in Table 3.1.6.4.1-5.

Table 3.1.6.4.1-5

Impacts of Offshore Tanker Ballasting and Purging Operations
Upon Ventura County Ozone Concentration. Trajectory arriving at
Simi Valley at 1400 PDT, assuming 1983 Conditions

	Initial Wind Speed	Ozone Concentrations (pphm)	
SCENARIO	(m/sec)	Baseline Run	Impact Run
Ballasting	3.0	17.0	24.7
	8.3	17.0	19.5
Purging	3.0	17.0	29.2
	8.3	17.0	21.9

3.1.6.4 Analysis of Onshore Air Quality Impact of Offshore Tankship Operations

3.1.6.4.2 Sulfur Dioxide

To simulate resultant SO_2 concentrations from tanker operations, a moving source Gaussian dispersion model was developed. The model predicts onshore concentration time histories from which peak concentrations can be determined.

Due to uncertainty in the dispersion of pollutants from moving sources, the dispersion parameters σ_y and σ_z were determined in two different manners, which are believed to bracket the possible results. In one case the parameters were determined from the Pasquill-Gifford stability charts using actual wind speed and in the other, using apparent wind speed. Results are presented for both cases, but it is believed that dispersion based on actual wind speed is more accurate when predicting concentrations at significant distances downstream.

The following assumptions concerning the ship and ambient air quality were used for the model:

1. The closest approach of the ship to shore is 8 kilometers.

2. The ship's course is parallel to the shoreline.

3. The ship's normal cruise speed is 15 knots.

4. Ambient onshore SO_2 concentrations are negligible.

A review of SO_2 emission rates for various size ships revealed that the highest emissions can be expected from 120,000 DWT ships burning 3% sulfur fuel.

Emission rates for 3 ship sizes under cruise conditions are listed in Table 3.1.6.4.2-1. The emissions calculations are based on the data of Williams Bros. (1976) and the EPA (1975) in Tables A3.1.6.1-4 and A3.1.6.1-5, respectively.

Table 3.1.6.4.2-1

Emission Rates for 3 Ship Sizes Under Cruise Conditions

Nominal Ship Size (DWT x 1000)	80	120	165
SO_2 Emission Rate (lb/hr)	233x%S	287x%S	258x%S
SO_2 Emission Rate (gm/sec)	29.4x%S	36.2x%S	32.5x%S
With .5% sulfur fuel (gm/sec)	14.7	18.1	16.3
With 3% sulfur fuel (gm/sec)	88.2	108.6	97.5

An emissions rate of 108.6 gm/sec was used for all cases in modeling.

The plume rise above the ship's stack was determined using Briggs' formula and the characteristics of the 120,000 DWT tanker, as presented in Table 3.1.6-A-4.

Meteorological data for three offshore regions were reviewed to determine frequencies of wind directions and speeds. The data is summarized in Tables 3.1.6.4.2-2 and 3.1.6.4.2-3, covering offshore Los Angeles and Ventura Counties. Very little data was available for the region offshore of Santa Barbara County, but the trends in the available data appear similar to Los Angeles data.

Wind speeds of 1, 3, and 5 meters/sec were used in the model and the wind direction was assumed to be normal to the shoreline (i.e. S and SSW winds). The meteorological review revealed that winds of S and SSW direction have frequencies of occurrence from .03 to .12 with generally higher frequencies in the spring and summer. The most common wind speed for S and SSW winds is 3 meters/sec.

Atmospheric stability over the 60°F water is considered to be neutral or stable and it is assumed that elevated inversion layers do not exist. The results are presented for the following 3 Pasquill-Turner stability categories:

D	Neutral
E	Slightly stable
F	Moderately stable.

Table 3.1.6.4.2-2

Zone 10 Eastern Ventura/Western L.A. Counties*

	Highest Freq.		Max.	2nd Highest Freq.		Freq. of Wind from S-SW	
Month	Speed	Direct	Speed	Speed	Direct	(22.5&45°)	Most freq. speed
Jan	3	W-WNW	17	3	NE-ENE	.04	3
Feb	3	W-WNW	≥20	5	W-WNW	.12	5
Mar	3	W	19	5	W	.07	3
Apr	3	W	19	≤2	W	.06	3
May	3	W	19	5	W	.12	3
Jun	3	W	15	≤2	W	.11	3
Jul	3	W	15	5	W	.10	3
Aug	5	W	13	7	W	.07	3
Sep	5	W-WNW	17	7	W-WNW	.06	3
Oct	5	W-WNW	13	3	W-WNW	.05	3
Nov	5	W-WNW	≥20	5	W-WNW	.05	3
Dec	5	W-WNW	19	3	W-WNW	.03	3

*Zone 10 extends from Latitude 33.5°N to 34°N and Longitude 118.5W to 119.°W.

Table 3.1.6.4.2-3

Zone 7 Ventura County*

	Highest Freq.		Max.	2nd Highest Freq.		Freq. of Wind from S-SW	
Month	Speed	Direct	Speed	Speed	Direct	(22.5&45°)	Most freq. speed
Jan	3	N-NE	≥20	≤2	NNE	.03	3
Feb	3	NE-NNE	15	≤2	NNE	.04	3
Mar	5	W	≥20	3	W	.05	3
Apr	5	W	≥20	3	W-WNW	.08	≤2
May	5	W	≥20	3	W	.06	3
Jun	5	W	13	3	W	.06	3
Jul	3	W-WNW	≥20	5	W-WNW	.05	≤2
Aug	3	W-WNW	13	5	W-WNW	.04	≤2
Sep	3	W	13	5	W-WNW	.03	≤2
Oct	3	W-WNW	≥20	≤2	NE	.06	≤2
Nov	≤2	NE	15	3	W	.03	3
Dec	≤2	NE	17	3	NE-ENE	.03	3

*Zone 7 extends from Latitude 34°N to 34.5°N and Longitude 119°W to 119.5°W.

The SO_2 peak concentrations onshore are presented in Table 3.1.6.4.2-4. Included are the results for case of a stationary ship, which represents an upper bound for potential SO_2 concentrations from a single offshore tankship. The worst case for a moving ship is slightly over 2 pphm predicted by using either the actual or apparent wind dispersion models for a moving source. The upper bound, stationary ship analysis yielded a worst case concentration of about 5 pphm. These concentrations are instantaneous in nature and still lie well below the California one-hour standard of 50 pphm. Hence, the SO_2 impacts due to offshore tankship operations appear to be negligible.

Table 3.1.6.4.2-4

Peak SO_2 Concentrations at the Shoreline

ug/m^3 (pphm)

A) Apparent Wind Model, V_3 = 15 knots (7.72 m/sec)

WIND SPEED (m/sec)	STABILITY D	E	F
1	4.82 (.18)	11.94 (.46)	24.55 (.94)
3	16.99 (.65)	32.69 (1.25)	52.18 (1.99)
5	26.29 (1.00)	44.38 (1.69)	60.53 (2.31)

B) Actual Wind Speed Model, V_5 = 15 knots

WIND SPEED (m/sec)	STABILITY D	E	F
1	--	1.29 (0.05)	0.03 --
3	40.08 (1.53)	50.42 (1.92)	28.8 (1.10)
5	49.82 (1.90)	57.90 (2.21)	42.54 (1.62)

C) Stationary Ship Model, V_5 = 0.

WIND SPEED (m/sec)	STABILITY D	E	F
1	--	10.02 (0.38)	0.225 --
3	110.61 (4.22)	139.16 (5.31)	79.5 (3.03)
5	91.66 (3.50)	106.53 (4.07)	78.28 (2.99)

Appendix A3.1.6

Methodology of Impact Analysis

Oxidant Methodology

Replace paragraph 1 as follows:

The evaluation of air quality impact is divided into three regions of the study area: (1) the Los Angeles Air Shed, (2) the areas along the pipeline route, and (3) the Midland terminal in Texas. Reflecting the severity of the baseline air quality problem and the availability of both ambient and emissions data, model studies have been performed to determine air quality for the Los Angeles and Midland regions. The Environmental Research and Technology contract submittal, which includes a detailed discussion of methodology, computer models, validation, inventories, et., is available upon request (BLM, 1976).

Addition to Bibliography:

G. H. Taylor, "Air Quality Impacts of Outer Continental Shelf Oil Development in the Santa Barbara Channel," Report P-5086, Environmental Research & Technology, Inc., Santa Barbara, California, 1977.

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